IN THE COURT OF ARBITRATION FOR SPORT

FLOYD LANDIS	)	
	)	
Appellant,	)	
	)	
V.	)	**CAS 2007/A/1394**
	)	
UNITED STATES ANTI-DOPING AGENCY	)	
	)	
Respondent.	)	
	)	

WITNESS STATEMENT OF DWIGHT E. MATTHEWS, Ph.D.

My name is Dwight E. Matthews. I reside at 279 Bishop Rd., Shelburne, Vermont 05482.

I. BACKGROUND

As part of my original Ph.D. thesis work in the 1970s, I developed the instrument that is now known as the GC-C-IRMS instrument for measuring isotope abundances for carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) from individual GC peaks. My background and qualifications are set forth in detail in my attached *curriculum vitae* and are summarized below.

I hold a B.A. degree in Chemistry from DePauw University (Greencastle, Indiana) (1973) and a Ph.D. degree in Analytical Chemistry from Indiana University (1977). I am a Professor of Chemistry and Chairman of the Department of Chemistry in the College of Arts and Sciences at the University of Vermont (UVM) in Burlington, Vermont. I am also a Professor of Medicine in the College of Medicine at UVM. I am currently the Director of the Mass Spectrometry Core Laboratory for the General Clinical Research Center, funded by the National Institutes of Health (NIH), and the Director of the Mass Spectrometry Facility of the College of Medicine at UVM and Co-Director of the Vermont Genetics Network Proteomics Mass Spectrometry Facility.

Prior to arriving at UVM in 1996, I was an Associate Professor of Biochemistry in the Departments of Medicine and Surgery at the Cornell University Medical College in New York City. At Cornell I also directed the Core Laboratories of the NIH-funded General Clinical Research Center that included both mass spectrometry and liquid chromatography equipment and assays for a range of metabolites including steroids.

Both my laboratory at Cornell and my current laboratory at UVM contain both isotope ratio mass spectrometers (IRMS) configured with continuous flow inlets, including a gas chromatograph connected to a combustion interface (GC-C-IRMS), and gas chromatograph-mass spectrometers (GCMS). I have been working in the field of IRMS ever since my Ph.D. work.

My research interests are developing analytical mass spectrometry methods to measure metabolites and pathways of metabolism in the human body using stable isotope tracers. I have used these methods to identify metabolites and measure their concentrations in human samples for a range of applications to study directly in humans amino acid and protein metabolism, glucose and carbohydrate metabolism, fatty acid and steroid metabolism. Precise and accurate measurement of small changes in natural abundance variations of carbon isotopes has been an important part of this work.

II. SUMMARY OF OPINIONS

I have received from USADA a variety of documents relating to the case of Floyd Landis v. the USADA. These documents include the original reports submitted by LNDD to USADA (the A & B doc packs), the 9/20/07 AAA decision submitted after completion of the arbitration proceeding, the 11/20/07 appeal brief from Landis, the 1/31/08 rebuttal brief from USADA in response to the appeal, and numerous other documents that have been generated and submitted with respect to these proceedings.

After reviewing all of these data and paying particular attention to the scientific data submitted by LNDD with respect to the stage 17 A and B samples of Landis analyzed by GCMS and by GC-C-IRMS for androgenic steroid metabolites in the urine, I concur with the opinion of LNDD that they have determined abnormal carbon-13 (^{13}C) content in a key urinary metabolite, (5α)-androstane-3α,17β-diol (abbreviated as "5α-Adiol" in this document) relative to a urinary steroid metabolite serving as an endogenous reference compound (ERC), in this case (5β)-pregnane-3α,20-diol (abbreviated as "Pdiol" in this document). Both 5α-Adiol and Pdiol are found in fraction F3 of LNDD's sample analysis.

The difference in the ^{13}C content in 5α-Adiol (being lower relative to Pdiol) is significantly greater than the measurement error of the LNDD, making this result highly significant. Furthermore, the difference in ^{13}C content between the 5α-Adiol and Pdiol is also beyond the allowed limit specified by WADA (technical document TD2004EAAS).

Landis has made several arguments in his appeal statement as to why the testing at LNDD failed to test his urine samples properly and why he believes that the positive results of his A and B samples from stage 17 are in error. The following provides my opinion on a number of the arguments that have been put forth in the appeal statement.

1. **Argument: the LNDD did not properly identify the metabolites of testosterone measured by the GC-C-IRMS instrument. Several arguments were put forward here.**

The first argument was that identification of each metabolite used for the $^{13}C/^{12}C$ measurement in the GC-C-IRMS chromatogram was invalid because the GC-C-IRMS cannot identify the structure of the compound eluting from the GC that the IRMS measures. The Landis appeal suggests that only the GCMS chromatogram provides positive identification and that the

GC-C-IRMS peak elution should match in time or relative retention time to the GCMS peak elution that were identified, else identification cannot be established.

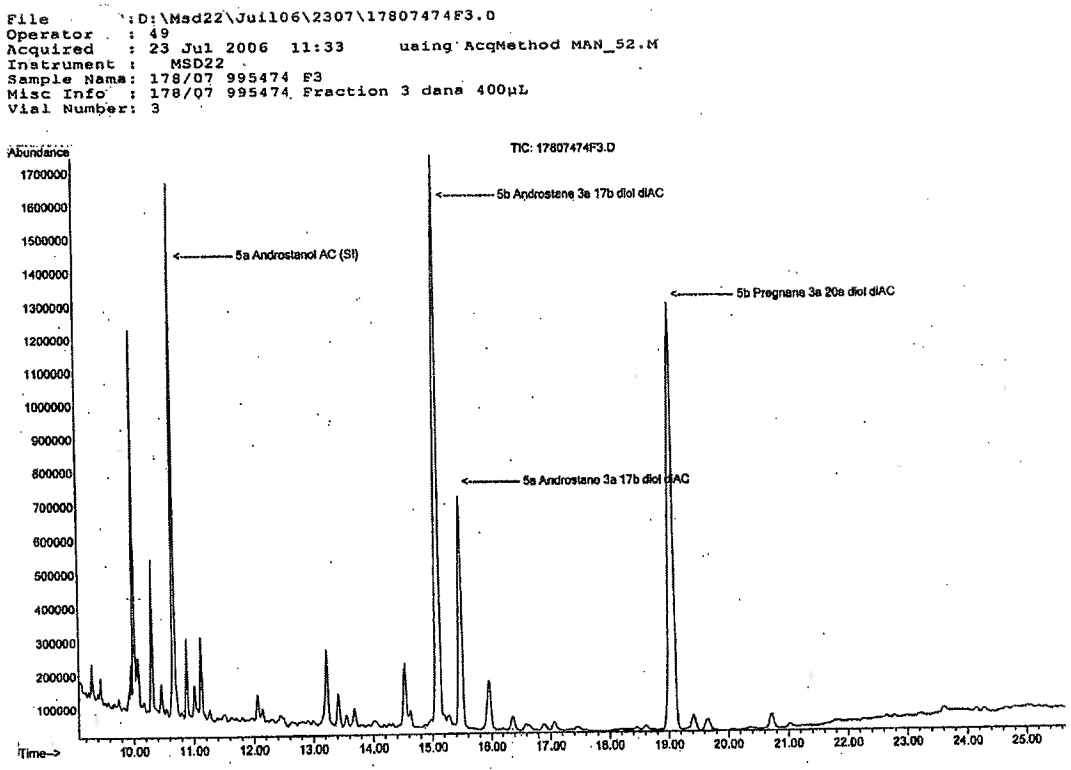
The argument that the GCMS and GC-C-IRMS peak elution times do not match either on an absolute or relative basis is specious. There is no reason that the two instruments' elution patterns would or should match in absolute or relative times. It is far more likely, and almost certain, that the elution times of peaks will not be identical between the GCMS and GC-C-IRMS even with the same GC column installed in both. The paths from start to finish are different. The end of the GC column in the GCMS goes straight into a vacuum system that is part of the ion source. That is, the pressure at the end of the GC column is *below* atmospheric pressure. The end of the GC column in the GC-C-IRMS goes into the oxidation tube and through more small-bore tubing before entering the ion source of the IRMS. The pressure at the end of the GC is *above* atmospheric pressure because it takes pressure to get the gas through the oxidation tube and down to the IRMS. These differences in flow paths change the chromatography with respect to absolute and relative retention times, and there is nothing that should or could be done about this difference. What will be true is that the elution pattern will be similar between the two instruments using the same GC column because it is the GC column that establishes the elution order.

Consider a road race where there are two paths to the finish. One driver (GCMS) chooses path A. Path A proceeds for some distance down a long highway that drops some in elevation as it goes. This part (the GC column) defines the majority of the race time. Then the highway descends in a straight line quickly to the finish (entrance to the GCMS). The other driver (GC-C-IRMS) chooses path B. Path B follows a similar initial highway (GC column), but with a slight uphill elevation to it. Then the highway proceeds upward rapidly on a windy road before

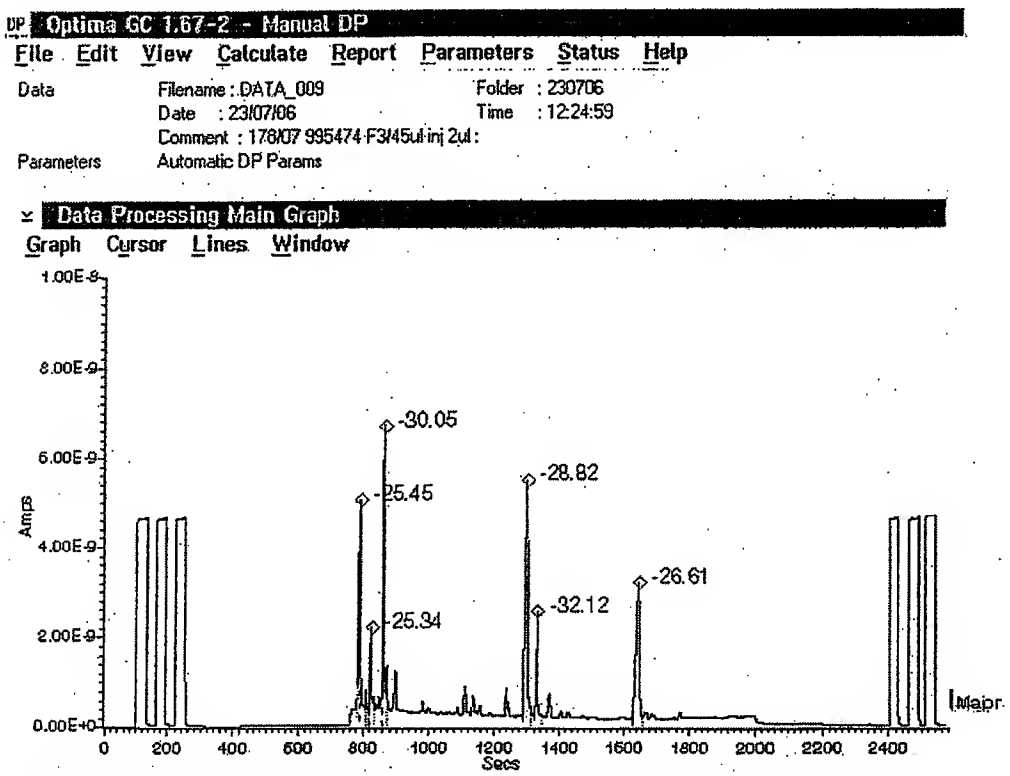
coming down to reach the finish. Who will finish first if the two cars have identical power? Driver GCMS.

The same is true if you add other pairs of drivers with different power levels in their cars (i.e. corresponds to the elution times of the different peaks): no pair of drivers would finish identically. You could speed up GC-C-IRMS drivers by giving them better fuel (done by altering the GC temperature conditions). However the effective power changes will be different for more and less powerful drivers so that the altered conditions might get one pair of driver GCMS and GC-C-IRMS to reach the finish line together, but that would not be true for all of the other pairs of drivers. With many pairs of drivers in different types of cars splitting between paths A & B, you will not find conditions where all pairs of drivers finish together or even with a set period of time between them. The affect of the downhill finish (the direct GCMS vacuum connection) versus the uphill road finish (the GC-C-IRMS) sets up a non-linear set of conditions for peak elution v. retention time. However, the pattern of the finish will be identical for both sets of drivers. That is, the order of finish of the GCMS drivers will be matched by the order of finish of the paired GC-C-IRMS drivers, even though the absolute and relative times do not pair up. The bottom line is that there is no scientific reason based upon how the instruments differ in their construction to expect exact elution times of peaks between the two instruments. You cannot add a simple offset in time, nor can you add a simple multiplier of time.

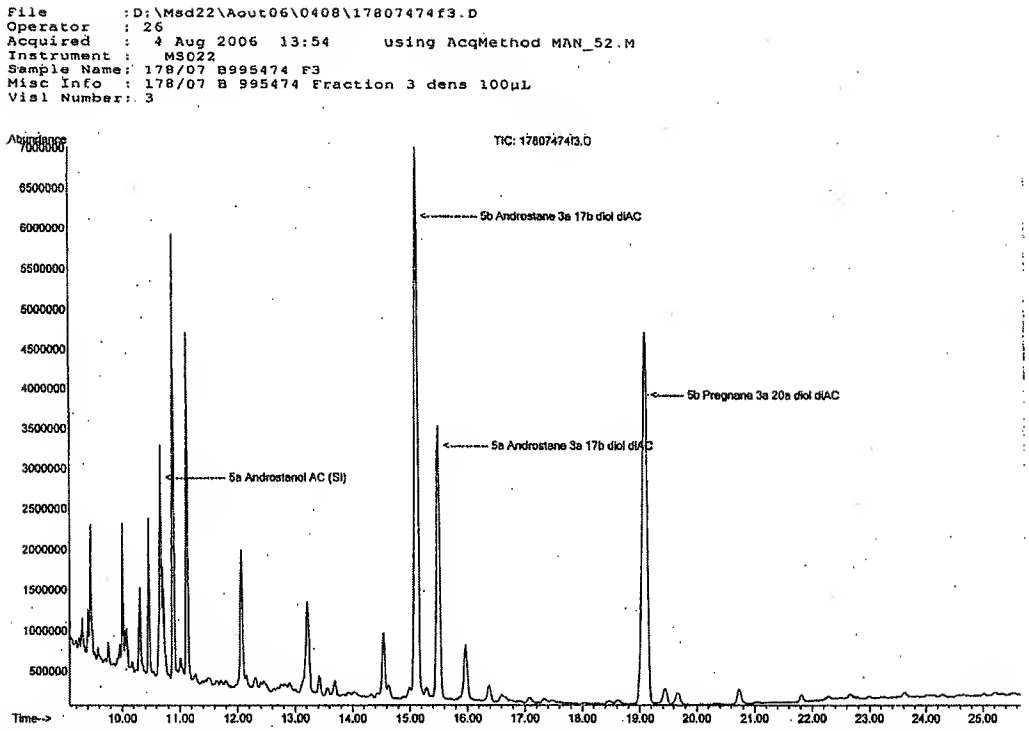
However, there is no question that the pattern of peak elution will be similar between the instruments when the same type of GC column is used for both. This observation is easily seen in the GCMS and GC-C-IRMS traces from the Landis stage 17 A & B sample analyses.



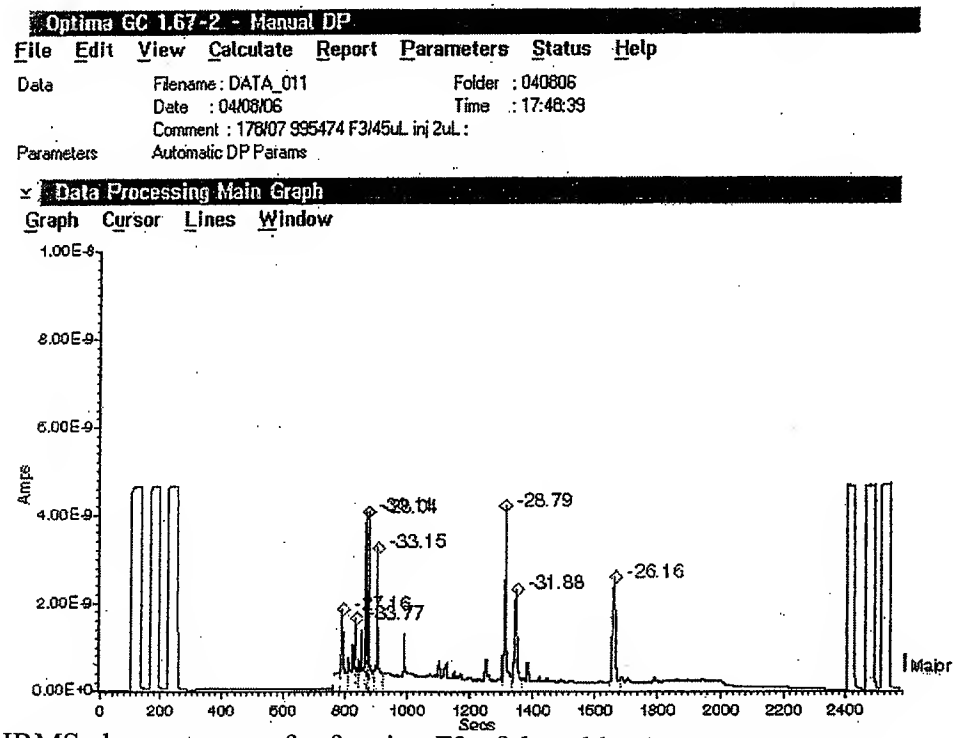
The GCMS chromatogram is from fraction F3 of the athlete's sample in the A documentation package (USADA0171).



The GC-C-IRMS chromatogram is for the A sample fraction F3 (USADA0173).



The GCMS chromatogram for fraction F3 of the athlete's sample from the B Sample documentation package (USADA0348).



The GC-C-IRMS chromatogram for fraction F3 of the athlete's sample from the B Sample documentation package (USADA0349).

The peak pattern is visible from looking at each of the two pairs of figures above. Peak elution order is the same on both instruments because elution order is set by the type of GC column used. The spacing between peaks will be altered by the type of GC program and conditions, but the elution order will not be affected. That is, peaks may be pushed together (i.e. be unresolved) with a poor GC program and pulled apart with a good GC program, but the order of peaks will not reverse by changing the GC program.

The large peak/small peak pattern will also be approximately the same in both the GCMS and GC-C-IRMS chromatograms because both chromatograms measure approximate amount of compound injected. The GCMS total ion chromatogram[1] measures the sum of all of the ions that are produced by a compound as it elutes, which is proportional to amount of material injected across a class of compounds that have similar molecular weights, such as steroids. The GC-C-IRMS measures the amount of CO_2 produced by the combustion of a peak as it elutes, which is also proportional to amount of compound.

For each fraction F3 chromatogram, we need to focus on the region where the key metabolites (i.e. 5β-Adiol, 5α-Adiol, and Pdiol) are being measured. We do know the elution time (retention time) of 5β-Adiol in both the GCMS and GC-C-IRMS because it is contained in the calibration standards injected for both instruments (the mix cal acetate standard for GC-C-IRMS). Once that peak is identified, it is a simple matter to find the 5α-Adiol, and Pdiol from the peak elution patterns. These patterns are further confirmed by the blank urine runs.

2. Argument: the LNDD was incompetent at operating their GC-C-IRMS instrument and that they lacked key controls.

[1]The GCMS operation is set to collect spectra, and to collect spectra repetitively over the course of the GC run. Each spectrum is collected at a specific point in time and stored. The GCMS trace shown is the so called "total ion chromatogram" where the sum of all ion signals for a single spectrum in time are summed together and plotted as an intensity point. The sum of the ion signals for a slice in time represents approximately how much material entered the mass spectrometer.

A. Good Controls:

In reviewing LNDD's protocol, I find their analytical scheme to be very well thought out with appropriate control samples added to each assay. LNDD runs a sequence of samples with each analytical sample that includes the reference CO_2 group (to define $^{13}C/^{12}C$ ratio measurement stability), the alkane mixture (to define $\delta^{13}C$ precision), the mix cal acetate (to define accuracy of $\delta^{13}C$ measurement), and the "blank" urine (to define sample preparation and matrix effects). The various controls establish a range of characterizations from stability, precision, accuracy, and linearity of ^{13}C measurement.

Another argument that was used was that the LNDD did not perform proper linearity testing. The linearity testing recommended by the manufacturer is of the linearity of amplification of the measured ion currents into signals that are then recorded. The LNDD lab does routinely prove linearity of response of the IRMS measurement system through injection of CO_2 gas pulses of varying magnitudes. The height of the pulse defines the flow rate of CO_2 into the source and the ion current that is then measured. The ion currents should go up and down among the channels measured that record the different isotope signals. The data provided by LNDD shows that by having minimal deviation in the mass-to-charge 45/44 ion current ratio (the basis for computing the $\delta^{13}C$) as a function of varying ion current (rate of CO_2 admitted into the IRMS) that the IRMS system was operating properly. Further, given the nature of the IRMS instrument, it is normally extremely stable, rugged and will remain in proper operating condition for a long period of time, such that linearity of response is very rarely ever an issue for IRMS. It is not uncommon for laboratories to check instrument linearity semiannually or at longer intervals.

A related complaint was that the LNDD failed to have proper positive control samples. The argument is distorted. The key question to ask is what is the purpose of the positive control in

the GC-C-IRMS assay? In most assays this criterion is applied for an administered *exogenous* compound that produces unnatural metabolites in urine. The positive control is designed to have these metabolites present and to allow the instrument to identify them positively. However, for this assay of administration of an *endogenous* substance (testosterone), the metabolites are already present in urine and are identified in the "blank" urine sample. The positive control in this case is to establish that the GC-C-IRMS can see a positive change in steroid metabolite ^{13}C content. The mix cal acetate sample accomplishes this task by having a 5β-Adiol standard as a positive tester of -33.8‰ for ^{13}C.

The mix cal acetate sample provides steroids of known $\delta^{13}C$ both lower (the 5β-Adiol, indicative of a positive test at -33.8‰) and higher $\delta^{13}C$ values, e.g. the (5β)-androstan-3α-ol-17-one (etiocholanolone, abbreviated here as "etio") at -19.9‰ and (5β)-androstan-3α-ol-11,17-dione (11-keto-etiocholanolone, abbreviated here as "ketoetio") at -16.3‰. (5α)-Androstane-3β-ol (5α-androstanol) has a $\delta^{13}C$ content in between these three. The measured $\delta^{13}C$ values of these steroids provide a calibration line for measurement of $\delta^{13}C$. If the instrument was not linear with respect to the measurement of ^{13}C content or if there was a measurement problem per se, the mix cal acetate $\delta^{13}C$ values would not have been on target.

B. "Good Chromatography"

Landis argues in his appeal that the LNDD has "poor chromatography" of the urinary steroid samples. From review of the data of these analyses, I do not see such problems. It is agreed that urine samples will contain more compounds than a select mixture of pure standards, but the separation of the key peaks that were measured in fraction F3 (5β-Adiol, 5α-Adiol, and Pdiol) do appear reasonably resolved and free from significant interference. The quality of the chromatograms from visual inspection of the stage 17 A & B fraction F3 (shown above) is not

significantly different from that of the "blank" urine also run during this period of analysis for the three key steroids.

It is important to focus on what was actually measured for the test in fraction F3: 5β-Adiol, 5α-Adiol, and Pdiol. It is in this region of the GC-C-IRMS chromatogram that attention should be paid. An argument was made in the appeal concerning "sloping baselines" where the baseline is higher at the beginning and lower at the end. However, looking at the F3 GC-C-IRMS chromatograms, you can see that there is a relatively unchanging baseline during the period of measurement interest (i.e. 5β-Adiol, 5α-Adiol, and Pdiol elution).

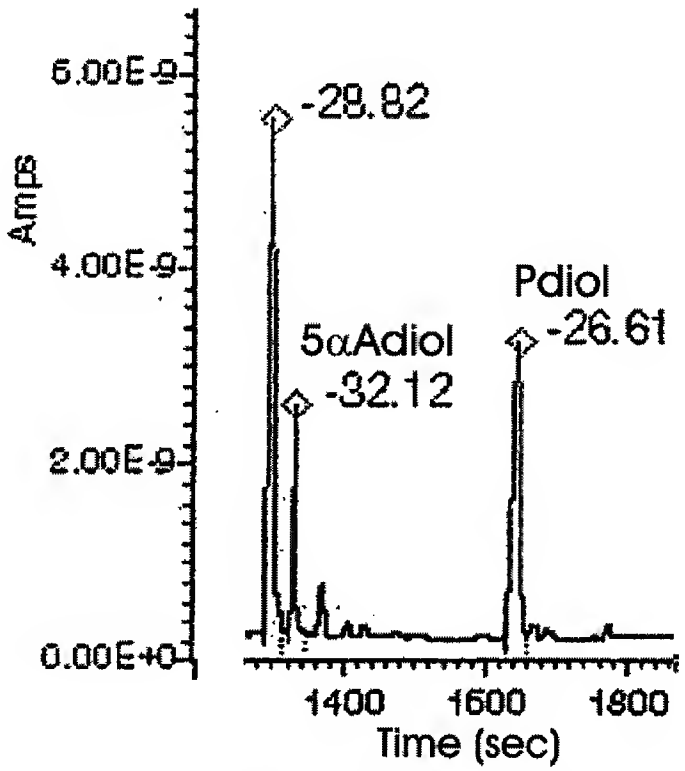


Figure from USADA 0173 "A" sample 995474 GC-C-IRMS chromatogram of fraction F3 focusing upon the baseline around 5α-Adiol and Pdiol peaks. The background in this region is essentially flat.

Another issue that was raised in the appeal was that there is a little peak seen between 5β-Adiol and 5α-Adiol in the GCMS chromatogram that is not seen in the GC-C-IRMS

chromatogram. The appeal argues that the little peak selectively moved to a later elution time and partially or fully co-elutes with 5α-Adiol. Given the elution pattern of the peaks in the GCMS and the observed elution pattern in the GC-C-IRMS showing separation of 5β-Adiol and 5α-Adiol, I would expect to find this little peak to also be between them, but it is just so small that it is too hard to see.

Even if the little peak moved selectively to a later elution time in the GC-C-IRMS chromatogram, it still remains a very minor peak that will make a very minor contribution to the measured 5α-Adiol $\delta^{13}C$ value. This opinion is based upon the standard mass balance equation in chemistry that defines the measured ^{13}C content observed when the compound is oxidized to CO_2 for measurement. The mass balance equation in this case states that the $^{13}CO_2$ produced by combustion of a mixture of (co-eluting) compounds is the weighted sum of the amount of each compound oxidized times its ^{13}C content.

A further argument was that the little peak may have a very negative $\delta^{13}C$ value and, if so, would influence the mass balance significantly to produce a low $\delta^{13}C$ value for 5α-Adiol. Because there is a relatively restricted limit to the natural range of ^{13}C abundance in materials in nature that might be in the F3 fraction, this argument is also specious. It is highly unlikely that the little peak is of such exotic ^{13}C abundance.

A final argument put forth was that the little peak could be of exotic, low ^{13}C abundance if it were combusted only in part and had a large isotopic fractionation imposed. Again, the argument is readily dismissed. Partial combustion (i.e. formation of carbon monoxide CO instead of CO_2) is a function of amount of material injected, such that in a properly functioning system, the oxidation tube must be overloaded with sample for partial combustion to occur. This could occur with big peaks, but not with very little peaks. The LNDD procedure uses a

functioning system where complete combustion occurs for amounts of material found in the urine samples, and the system is tested to be functioning (e.g. by the accurate $\delta^{13}C$ values measured for the mix cal acetate). The GC-C-IRMS was functioning properly when the stage 17 samples were measured, based upon the results of the standards that were run. If so, then a little peak will not selectively partially combust.

For all of the above reasons, I dismiss the various unrelated arguments that the observed "little peak" between 5β-Adiol and 5α-Adiol observed in the GCMS chromatogram significantly influenced the 5α-Adiol $\delta^{13}C$ measurement by GC-C-IRMS.

Another part of the Landis argument was that the variability of the ^{13}C measurement of the 5α-androstanol was outside the 0.5‰ range established by the LNDD standard operating protocol. This statement is not true; the 5α-androstanol is used as retention time marker, not as a $\delta^{13}C$ standard, except when run within the mix cal acetate sample. The 0.5‰ criterion of the LNDD applies to having 3 of 4 steroids in the mix cal acetate fall within this range. This criterion applies to this specific standard set of steroids. It does not apply across chromatograms and sample types (e.g. different fraction analyses: F1, F2, & F3) for a single analyte. Further, the 5α-androstanol plays no role in the $\Delta\delta^{13}C$ calculation in fraction F3.

3. Argument: there was a break in time between sample injections during both the A and B sample analyses.

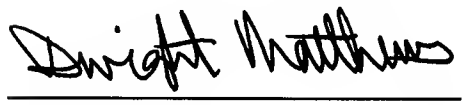
My response to this argument is that it doesn't matter. As I mentioned above, LNDD runs a sequence of samples to test instrument stability, precision and accuracy with each analytical sample. With these controls LNDD has established that the instrument operates the same from day to day. A sidelight of these measurements is that, therefore, there is no change in instrument response when left overnight with no samples being run and that the instrument is stable for

extended periods of time. Therefore, a four or five hour delay during an injection sequence will not affect the instrument's ability to measure ^{13}C content precisely and accurately.

The LNDD method is also conservative. By measuring the mix cal acetate both before and after sample analysis, they have built into their system an additional check to demonstrate that the time between start and stop of sample analysis has not affected results. The results of the mix cal acetate sample measurements before and after measurement of the Landis stage 17 A & B samples are consistent with a perfectly normal operating instrument during the measurement period in question. No break in analysis sequence has affected instrument operation.

The Landis appeal suggests that the $\delta^{13}C$ values were produced for specific steroids (e.g. the 5α-Adiol) by manipulation of the data through manual integration of the peaks, background subtraction and/or poorly controlled automatic integration. The bottom line remains that when the background signal is relatively minor, as it is in this case, subtraction of the background has relatively little influence. Influence is further diminished when the background level is similar between the two peaks from which a $\Delta\delta^{13}C$ difference is obtained. That is, similar effects to 5α-Adiol and Pdiol will cancel for the Δδ calculation: $\Delta = \delta^{13}C(5\alpha\text{-Adiol}) - \delta^{13}C(\text{Pdiol})$. These two aspects (small background signal and consistent differences for both analytes) minimize the effect of background subtraction. A similar argument is readily made for small differences in background integration limits (peak start and stop definition) when both compounds are similarly affected. The documents provided for reprocessing the samples by different methods confirm this opinion because even when the samples were reprocessed with *no* background subtraction, the $\Delta\delta^{13}C$ results were still significantly greater than 3‰. All processing approaches came to the same positive conclusion.

I declare under penalty of perjury of the laws of the state of New York that the foregoing is true and accurate. This statement was executed on March 7, 2008, in Burlington, Vermont.



Dwight E. Matthews

CURRICULUM VITAE

Dwight E. Matthews

PERSONAL:

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EDUCATION:

B.A. - DePauw University, Greencastle, Indiana, May 1973.
Ph.D. - Analytical Chemistry, Indiana University, Bloomington, Indiana, December 1977.

ACADEMIC APPOINTMENTS:

9/1977 - 7/1980:	Research Instructor of Medicine, Washington University School of Medicine, St. Louis, Missouri
7/1980 - 7/1986:	Research Assistant Professor of Medicine, Washington University School of Medicine, St. Louis, Missouri
7/1986 - 6/1996:	Associate Professor of Biochemistry in Medicine with tenure, Cornell University Medical College, New York, N.Y.
7/1987 - 6/1996:	Associate Professor of Biochemistry in Surgery with tenure, Cornell University Medical College, New York, N.Y.
7/1996 -	Professor of Medicine with tenure, College of Medicine, the University of Vermont Burlington, Vermont
7/1996 -	Professor of Chemistry, College of Arts and Sciences, University of Vermont, Burlington, Vermont
7/1996 -	Member of the Graduate College Faculty, University of Vermont, Burlington, Vermont
9/2001 -	Member of the Cell and Molecular Biology Program, University of Vermont, Burlington, Vermont

ADMINISTRATIVE APPOINTMENTS:

7/1986 - 6/1996:	Director of the Mass Spectrometry Facility in Medicine, Cornell University Medical College, New York, N.Y.
7/1987 - 6/1996:	Director of the General Clinical Research Center Core Laboratory, Cornell University Medical College, New York, N.Y.
7/1996 -	Director of the Mass Spectrometry Facility in the Clinical Research Center, University of Vermont College of Medicine, Burlington, Vermont
7/2002 -	Chairman, Department of Chemistry, College of Arts and Sciences, University of Vermont, Burlington, Vermont

PROFESSIONAL MEMBERSHIPS:

American Chemical Society (ACS)	1975
American Federation for Medical Research (AFMR, *formerly Am. Fed. Clin. Res.*)	1986
American Physiological Society (APS)	1989
American Society for Biochemistry & Molecular Biology (ASBMB)	2002
American Society for Mass Spectrometry (ASMS)	1975
American Society for Nutrition (ASN) *reorganized in 2006 from*	1984
American Society for Clinical Nutrition (ASCN)	
American Society for Nutritional Sciences (ASNS, *formerly the Am. Inst. of Nutrition, AIN*)	

American Society for Parenteral and Enteral Nutrition (ASPEN) 1983

EXTRAMURAL ACTIVITIES:

2/1985 - 1/1988	ASPEN Membership Committee
2/1988 - 1/1990	ASPEN Research and Data Committee
7/1988 - 12/1991	Contributing Editor, **Nutrition Reviews**
1/1989 - 12/1991	ASCN/19AIN/19ASPEN Joint Committee on Ethics
6/1990 - 5/1991	ASCN Annual Meeting Program Committee
7/1990 - 12/1997	Editorial Board, **American Journal of Physiology: Endocrinology & Metabolism**
10/1990 - 12/2005	Associate Editor, **Journal of Parenteral and Enteral Nutrition (JPEN)**
7/1991 - 6/1997	Editorial Board, **Analytical Biochemistry**
2/1994 - 1/1996	ASPEN Research and Data Committee
9/1996 - 1/1997	Natural Sciences and Engineering Research Council of Canada Advisory Committee on SLOWPOKE Nuclear Reactors
1/1997 -	Editorial Board, **Current Opinion in Clinical Nutrition and Metabolic Care**
1/1997 -	Section Editor, *Assessment of Nutritional Status and Analytical Methods*, **Current Opinion in Clinical Nutrition and Metabolic Care**
2/1997 - 1/1998	ASPEN Publications Committee
5/1997 -	External Advisory Committee, Washington University Biomedical Mass Spectrometry NIH Resource, St. Louis, Missouri
2/1998 - 1/1999	Board of Directors, ASPEN
2/1998 - 3/2001	Chairman, ASPEN Research Committee
4/1998 - 12/1998	Chairman, JPEN Editor Search Committee, ASPEN
2/2000 - 1/2001	ASPEN Nominations Committee
5/2003 - 6/2006	Committee on Measurements and Standards, ASMS
1/2006 - 12/2007	Editorial Board, **Journal of Parenteral and Enteral Nutrition (JPEN)**
1/2006 -	Advisory Board, **Sport Sciences for Health**
3/2008 - 2/2011	Science Advisory Board, DePauw University, Greencastle, Indiana

INTRAMURAL ACTIVITIES:

University of Vermont:

7/1996 - 6/1999	Chair, Clinical Research Center Mass Spectrometry Users Committee
7/1998 - 6/2003	Chair, Department of Chemistry Instrumentation Committee
7/1998 - 3/2000	Department of Chemistry Faculty Search Committee in Analytical Chemistry
3/1999 -	Department of Chemistry Space and Building Committee
11/1999 - 6/2001	Graduate College Graduate Fellowship Review Panel
7/2001 -	Biochemistry Undergraduate Program Steering Committee, Colleges of Agriculture & Life Sciences, Arts & Sciences, and Medicine
8/2001 - 4/2003	Chair, Search Committee for the Department of Nutrition and Food Sciences Chair, College of Agriculture & Life Sciences
2/2003 – 6/2006	President's Commission on Racial Diversity
3/2003 - 10/2003	Chair, Review Committee of the Department of Physics Chair, College of Arts & Sciences
5/2006	Chair, Graduate College University Scholar Review Panel for the Sciences
9/2006 -8/2007	Chair, Search Committee for the Department of Physics Chair, College of Arts & Sciences

AWARDS:

2004 University Scholar, University of Vermont
2007 Member, Vermont Academy of Science and Engineering

NIH PEER REVIEW RESPONSIBILITIES:

Study section memberships:

7/1/2005 - 6/30/2008	Member, Integrative Nutrition and Metabolic Processes (INMP) Study Section

7/1/2006 - 6/30/2008 Chair, Integrative Nutrition and Metabolic Processes (INMP) Study Section

Past ad hoc memberships:
Physiological Chemistry Study Section (7/1985)
Experimental Therapeutics Study Section (6/1985)
GM: Postdoctoral Training in Trauma and Burn Program (3/1988)
DK: Clinical Nutrition Research Unit Program Review Committee (4/1988)
DK: Clinical Nutrition Research Unit Program Special Emphasis Panel Review (4/1999)
RR: General Clinical Research Centers Review Committee (2/2002)
Nutrition Study Section (NTN: 2/2003, 10/2003, 2/2004)
Integrated Nutrition and Metabolic Processes Study Section (INMP: 6/2004, 10/2004, 2/2005, 6/2005)
Special Emphasis Panel/Review Group, Endocrinology & Reproductive Sciences Integrated Review Group (REB01: 3/28/2003, REB02: 11/18/2003)
Special Emphasis Panel/Review Group, Reproductive Biology Sciences (11/14/2003)
Special Emphasis Panel/Review Group, ZRG1 ENMR-A (6/30/2004)
DK: Clinical Nutrition Research Unit Program Special Emphasis Panel ZDK1-GB-1 M2 (3/2005)
Special Emphasis Panel/Review Group, Shared-Instrument Grant Program – NCRR (10/2003, 11/2004; 7/2005, 7/2006, 7/2007)
DK: Obesity Nutrition Research Unit Program Special Emphasis Panel ZDK1 GRB6 (12/2007)

Past site visits for:
DK - Diabetes, Digestive and Kidney Diseases (8/84, 6/86)
GM - General Medical Sciences (3/88)
HD - Child Health (1/85, 2/88, 9/90, 5/91, 5/92)
NCI - National Cancer Institute (10/93)
NS - Neurological and Communicative Disorders and Stroke (2/86)
RR - Division of Research Resources, NCRR; General Clinical Research Center reviews (12/89, 6/94, 8/2000, 7/2003)

CANADIAN RESPONSIBILITIES:
National Research Council NSERC Special Review Panel for Slow Poke Reactors (9/96-12/96)
Canadian Foundation for Innovation Expert Review Committee (5/99)

CONSULTING:
SmithKline Beecham Pharmaceuticals (2/02 - 7/02)
R. W. Johnson Pharmaceutical Research Institute (7/01 - 12/01)
Merck Research Laboratories (3/05 – 8/05)
Nestlé Research Center (1/05 -)

REVIEWER FOR JOURNALS (for the last 5 years):
American Journal of Clinical Nutrition
American Journal of Physiology
Analytical Biochemistry
Analytical Chemistry
Clinical Chemistry
Coronary Artery Disease
Diabetes
Gastroenterology
Hepatology
Journal of the American Society for Mass Spectrometry
Journal of Clinical Endocrinology & Metabolism
Journal of Clinical Investigation

Journal of Mass Spectrometry
Journal of Nutrition
Journal of Parenteral and Enteral Nutrition
Journal of Physiology
Metabolism
Nature
Obesity Research
Proceedings of the National Academy of Science

TEACHING:

1. CHEM 228: Analytical Chemistry Special Topics: Mass Spectrometry, the University of Vermont, spring 1998. *Three credit hours.*
2. CHEM 228: Analytical Chemistry Special Topics: Mass Spectrometry, the University of Vermont, fall 1999. *Three credit hours.*
3. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2001. *Three credit hours.*
4. CHEM 228: Analytical Chemistry Special Topics: Mass Spectrometry, the University of Vermont, fall semester 2001. *Three credit hours.*
5. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2002. *Three credit hours.*
6. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2003. *Three credit hours.*
7. CHEM 223: Mass Spectrometry, the University of Vermont, fall 2003. *Three credit hours.*
8. CHEM 039: Introduction to Research, the University of Vermont, fall 2003. *Two credit hours.*
9. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2004. *Three credit hours.*
10. CHEM 040: Introduction to Research, the University of Vermont, spring 2004. *Two credit hours.*
11. MD 566 Nutrition, Metabolism and Gastroenterological Systems, Vermont Integrated Curriculum, College of Medicine, spring 2004. *Lectures to medical students in their first year; 7.5 contact hours.*
12. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2005. *Three credit hours.*
13. MD 566 Nutrition, Metabolism and Gastroenterological Systems, Vermont Integrated Curriculum, College of Medicine, spring 2005. *Lectures to medical students in their first year; 6 contact hours.*
14. CHEM 223: Mass Spectrometry, the University of Vermont, fall 2005. *Three credit hours.*
15. MD 566 Nutrition, Metabolism and Gastroenterological Systems, Vermont Integrated Curriculum, College of Medicine, spring 2006. *Lectures to medical students in their first year; 5 contact hours.*
16. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2006. *Three credit hours.*
17. CHEM 201: Advanced Chemistry Laboratory, the University of Vermont, spring 2007. *Three credit hours.*
18. CHEM 223: Mass Spectrometry, the University of Vermont, fall 2007. *Three credit hours.*

Didactic Lectures, Workshops and Short Courses:

1. Mini-course on *Protein and Energy Metabolism*, Department of Food and Nutrition, Barnes Hospital, St. Louis, Mo. Nov. 20, 1985.
2. Lectures in Stable Isotope Tracers in Metabolism as Visiting Professor, Medizinische Klinik IV, Allgemeines Krankenhaus der Stadt, Vienna, Austria, June 22, 1994.
3. Lectures in the *Biochemical and Physiological Bases of Nutrition* course, Institute of Human Nutrition, Columbia University College of Physicians and Surgeons, New York, NY, October 17, 1994.
4. Lectures in the *Principles of Nutrition Research* course in the Department of Nutritional Sciences, Rutgers University, New Brunswick, New Jersey, October 24, 1994.
5. Lectures in *Advanced Nutrition* in the Departments of Health and Nutrition Education, Columbia University Teachers College, November 14 & 21, 1995.
6. Mini-course lecture series, *Stable Isotope Tracers and Mass Spectrometry*, Clinical Research Center, Cornell University Medical College, December 1995 - January 1996.
7. ESPEN (European Society of Parenteral & Enteral Nutrition) Two-Day Course in *Tracer Methodology in Metabolism*, Maastricht, the Netherlands, January 31 - February 1, 2004. *Three lectures.*
8. American Society for Mass Spectrometry Two-Day Short Course on *Quantitative Mass Spectrometry*, Nashville, TN, May 22-23, 2004.

9. ESPEN (European Society of Parenteral & Enteral Nutrition) Two-Day Course in *Tracer Methodology in Metabolism*, Maastricht, the Netherlands, February 5-6, 2005. *Four lectures.*
10. American Society for Mass Spectrometry Two-Day Short Course on *Quantitative Mass Spectrometry*, San Antonio, TX, June 4-5, 2005.
11. American Society for Mass Spectrometry Two-Day Short Course on *Quantitative Mass Spectrometry*, Seattle, WA, May 27-28, 2006.
12. ESPEN (European Society of Parenteral & Enteral Nutrition) Two-Day Course in *Tracer Methodology in Metabolism*, Stockholm, Sweden, June 10-11, 2006. *Four lectures.*
13. The Academy of Muscle Biology, Exercise and Health Research (Copenhagen, Denmark) Winter Symposium in Methods in Research – From Molecule to Man, St. Christoph, Austria, January 13-20, 2007. *Lecture and five days of directing student thesis research planning and manuscript writing.*
14. NIH-NIDDK sponsored 5-day course on *Isotope Tracers in Metabolic Research: Principles and Practice of Kinetic Analysis*, Little Rock, Arkansas, October 8-11, 2007. *Two lectures.*

Organizer of symposia and workshops:

Regulation of Energy Metabolism, 14th Clinical Congress, American Society for Parenteral and Enteral Nutrition, San Antonio, Texas, January 28, 1990 (published as: DE Matthews & SB Heymsfield: ASPEN 1990 research workshop on energy metabolism. *J. Parent. Ent. Nutr.* 15:3_14, 1991).

Body Composition, 17th Clinical Congress, American Society for Parenteral and Enteral Nutrition, San Diego, Calif., February 14, 1993 . (published as: SB Heymsfield & DE Matthews: Body composition: Research and clinical advances 1993 A.S.P.E.N. research workshop. *J. Parent. Ent. Nutr.* 18:91_103, 1994).

Modeling of Protein and Amino Acid Metabolism, International Federation of Automatic Control Conference on *Modeling and Control in Biomedical Systems*, Galveston, Texas, March 27-30, 1994 (published as: *Kinetic Modeling: Modeling of Protein and Amino Acid Metabolism in Modeling and Control in Biomedical Systems*, Proceedings of the IFAC Symposium, B.W. Patterson, ed., Omnipress, 1994).

NIH NIDDK-sponsored Research Workshop on *Using Tracers to Measure Carbohydrate, Fat and Amino Acid Metabolism in Humans*, Nutrition Week 2003, San Antonio, Texas, January 18, 2003.

ESPEN (European Society of Parenteral & Enteral Nutrition) Two-Day Course in *Tracer Methodology in Metabolism,* Maastricht, the Netherlands, Feb. 2004 & 2005, Stockholm, Sweden, June 2006.

REFEREED PUBLICATIONS:

1. DE Matthews & JM Hayes: Systematic errors in gas chromatography-mass spectrometry isotope ratio measurements. *Anal. Chem.* 48: 1375-1382, 1976.

2. JM Hayes, DE Matthews & DA Schoeller: The 'effective deadtime' of pulse-counting detector systems. *Anal. Chem.* 50: 25-32, 1978.

3. DE Matthews, KB Denson & JM Hayes: Evaluation of the dynamic performance of selected ion monitoring mass spectrometers. *Anal. Chem.* 50: 681-683, 1978.

4. DE Matthews & JM Hayes: Isotope-ratio-monitoring gas chromatography-mass spectrometry. *Anal. Chem.* 50: 1465-1473, 1978.

5. DE Matthews, E Ben Galim & DM Bier: Determination of stable isotopic enrichment in individual plasma amino acids by chemical ionization mass spectrometry. *Anal. Chem.* 51: 80-84, 1979.

6. JF Burke, RR Wolfe, CJ Mullany, DE Matthews & DM Bier: Glucose requirements following burn injury: Parameters of optimal glucose infusion and possible hepatic and respiratory abnormalities following excessive glucose intake. *Ann. Surg.* 190: 274-285, 1979.

7. DE Matthews, KJ Motil, DK Rohrbaugh, JF Burke, VR Young & DM Bier: Measurement of leucine metabolism in man from a primed, continuous infusion of L-[1-^{13}C]leucine. *Am. J. Physiol. Endocrinol. Metab.* 238: E473-E479, 1980.

8. DE Matthews, E Ben Galim, MW Haymond & DM Bier: Alloisoleucine formation in Maple Syrup Urine Disease: Isotopic evidence for the mechanism. *Pediatr. Res.* 14: 854-857, 1980.

9. E Ben Galim, K Hruska, DM Bier, DE Matthews & MW Haymond: Branched-chain amino acid nitrogen transfer to alanine in vivo: Direct isotopic determination with [^{15}N]leucine. *J. Clin. Invest.* 66: 1295-1304, 1980.

10. M Gersovitz, DM Bier, DE Matthews, J Udall, HN Munro & VR Young: Dynamic aspects of whole body glycine metabolism: Influence of protein intake in young adult and elderly males. *Metabolism* 29: 1087-1094, 1980.

11. DE Matthews, JB Starren, AJ Drexler, DM Kipnis & DM Bier: Picomole assay for N^{τ}-methylhistidine by gas chromatography-mass spectrometry. *Anal. Biochem.* 110: 308-317, 1981.

12. KJ Motil, DE Matthews, DM Bier, JF Burke, HN Munro & VR Young: Whole body leucine and lysine metabolism: Response to altered dietary protein intake in young men. *Am. J. Physiol. Endocrinol. Metab.* 240: E712-E721, 1981.

13. KJ Motil, DM Bier, DE Matthews, JF Burke & VR Young: Whole body leucine and lysine metabolism studied with [1-^{13}C]leucine and [α-^{15}N]lysine: Response in healthy young men given excess energy intake. *Metabolism* 30: 783-791, 1981.

14. DE Matthews, DM Bier, MJ Rennie, RHT Edwards, D Halliday, DJ Millward & GA Clugston: Regulation of leucine metabolism in man: A stable isotope study. *Science* 214: 1129-1131, 1981.

15. DE Matthews, JM Conway, VR Young & DM Bier: Glycine nitrogen metabolism in man. *Metabolism* 30: 886-893, 1981.

16. R Matalon, DE Matthews, K Michals & DM Bier: The use of deuterated phenylalanine for the in vivo assay of phenylalanine hydroxylase activity in children. *J. Inherited Metab. Dis.* 5: 17-19, 1982.

17. KJ Motil, RJ Grand, DE Matthews, DM Bier, CJ Maletskos & VR Young: Whole body leucine metabolism in adolescents with Crohn's disease and growth failure during nutritional supplementation. *Gastroenterology* 82: 1359-1368, 1982.

18. MJ Rennie, RHT Edwards, D Halliday, DE Matthews, SL Wolman & DJ Millward: Muscle protein synthesis measured by stable isotope techniques in man: The effects of feeding and fasting. *Clin. Sci.* 63: 519-523, 1982.

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19. MJ Rennie, RHT Edwards, DJ Millward, SL Wolman, D Halliday & DE Matthews: The effects of Duchenne muscular dystrophy on muscle protein synthesis. *Nature* 296: 165-167, 1982.

20. WJ Malaisse, A Sener, F Malaisse-Lagae, M Welsh, DE Matthews, DM Bier & C Hellerstrom: The stimulus-secretion coupling of amino acid-induced insulin release: Metabolic response of pancreatic islets to L-glutamine and L-leucine. *J. Biol. Chem.* 257: 8731-8737, 1982.

21. DM Bier & DE Matthews: Stable isotope tracer methods for in vivo investigations. *Fed. Proc.* 41: 2679-2685, 1982.

22. DJ Millward, CTM Davies, D Halliday, SL Wolman, DE Matthews & MJ Rennie: Effect of exercise on protein metabolism in humans as explored with stable isotopes. *Fed. Proc.* 41: 2686-2691, 1982.

23. DE Matthews, HP Schwarz, RD Yang, KJ Motil, VR Young & DM Bier: Relationship of plasma leucine and α-ketoisocaproate during a L-[1-^{13}C]leucine infusion in man: A method for measuring human intracellular leucine tracer enrichment. *Metabolism* 31: 1105-1112, 1982.

24. JJ Robert, DM Bier, X-H Zhao, DE Matthews & VR Young: Glucose and insulin effects on de novo amino acid synthesis in young men: Studies with stable isotope labeled alanine, glycine, leucine, and lysine. *Metabolism* 31: 1210-1218, 1982.

25. JJ Robert, JC Cummins, RR Wolfe, M Durkot, DE Matthews, X-H Zhao, DM Bier & VR Young: Quantitative aspects of glucose production and metabolism in healthy elderly subjects. *Diabetes* 31: 203-211, 1982.

26. MWN Ward, D Halliday, DE Matthews, SM Matthews, JL Peters, RA Harrison, CG Clark & MJ Rennie: The effect of enteral nutritional support on skeletal muscle protein synthesis and whole-body protein turnover in fasted surgical patients. *Hum. Nutr. Clin. Nutr.* 37: 453-458, 1983.

27. RD Yang, LL Moldawer, A Sakamoto, RA Keenan, DE Matthews, VR Young, RW Wannemacher, Jr., GL Blackburn & BR Bistrian: Leukocyte endogenous mediator alters protein dynamics in rats. *Metabolism* 32: 654-660, 1983.

28. JE Heubi, S Burstein, MA Sperling, D Gregg, MTR Subbiah & DE Matthews: The role of human growth hormone in the regulation of cholesterol and bile acid metabolism. *J. Clin. Endocrinol. Metab.* 57: 885-891, 1983.

29. EJ Norman, JE Heubi, MJ Gelfand, P Dan & DE Matthews: Chenodeoxycholic acid pool size determination from children using isotope dilution mass spectrometry. *Biol. Mass Spectrom.* 11: 269-272, 1984.

30. MA Staten, DM Bier & DE Matthews: Regulation of valine metabolism in man: A stable isotope study. *Am. J. Clin. Nutr.* 40: 1224-1234, 1984.

31. DE Matthews & RS Downey: Measurement of urea kinetics in humans: A validation of stable isotope tracer methods. *Am. J. Physiol. Endocrinol. Metab.* 246: E519-E527, 1984.

32. RD Yang, DE Matthews, DM Bier, C Lo & VR Young: Alanine kinetics in man: Influence of different isotopic tracers. *Am. J. Physiol. Endocrinol. Metab.* 247: E634-E638, 1984.

33. LJ Hoffer, BR Bistrian, VR Young, GL Blackburn & DE Matthews: Metabolic effects of very low calorie weight reduction diets. *J. Clin. Invest.* 73: 750-758, 1984.

34. RA Gelfand, DE Matthews, DM Bier & RS Sherwin: Role of counterregulatory hormones in the catabolic response to stress. *J. Clin. Invest.* 74: 2238-2248, 1984.

35. JJ Robert, DM Bier, D Schoeller, RR Wolfe, DE Matthews, HN Munro & VR Young: Effects of intravenous glucose on whole body leucine dynamics, studied with 1-^{13}C-leucine, in healthy young and elderly adults. *J. Gerontol.* 39: 673-681, 1984.

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36. LJ Hoffer, RD Yang, DE Matthews, BR Bistrian, DM Bier & VR Young: Effects of meal consumption on whole body leucine and alanine kinetics in young adult men. *Br. J. Nutr.* 53: 31-38, 1985.

37. D Darmaun, MJ Manary & DE Matthews: A method for measuring both glutamine and glutamate levels in stable isotopic enrichments. *Anal. Biochem.* 147: 92-102, 1985.

38. YM Yu, RD Yang, DE Matthews, Z-M Wen, JF Burke, DM Bier & VR Young: Quantitative aspects of glycine and alanine metabolism in postabsorptive young men: Effects of level of nitrogen and indispensable amino acid intake. *J. Nutr.* 115: 399-410, 1985.

39. WJ Millikan, JM Henderson, JR Galloway, WD Warren, DE Matthews, A McGhee & MH Kutner: In vivo measurement of leucine metabolism with stable isotopes in normal and cirrhotic subjects fed conventional and branched-chain amino acid enriched diets. *Surgery* 98: 405-412, 1985.

40. NK Fukagawa, KL Minaker, JW Rowe, MN Goodman, DE Matthews, DM Bier & VR Young: Insulin-mediated reduction of whole body protein breakdown: Dose-response effects of leucine metabolism in postabsorptive men. *J. Clin. Invest.* 76: 2306-2311, 1985.

41. RS Downey, WW Monafo, lE Karl, DE Matthews & DM Bier: Protein dynamics in skeletal muscle after trauma: Local and systemic effects. *Surgery* 99: 265-273, 1986.

42. RS Downey, A Mellone & DE Matthews: Effects of tracer infusion site on measurement of bicarbonate-carbon dioxide metabolism in dogs. *J. Appl. Physiol.* 60: 1248-1253, 1986.

43. MM Meguid, DE Matthews, DM Bier, CN Meredith, JS Soeldner & VR Young: Leucine kinetics at graded leucine intakes in young men. *Am. J. Clin. Nutr.* 43: 770-780, 1986.

44. MM Meguid, DE Matthews, DM Bier, CN Meredith & VR Young: Valine kinetics at graded valine intakes in young men. *Am. J. Clin. Nutr.* 43: 781-786, 1986.

45. CN Meredith, Z-M Wen, DM Bier, DE Matthews & VR Young: Lysine kinetics at graded lysine intakes in young men. *Am. J. Clin. Nutr.* 43: 787-794, 1986.

46. X-H Zhao, Z-M Wen, CN Meredith, DE Matthews, DM Bier & VR Young: Threonine kinetics at graded threonine intakes in young men. *Am. J. Clin. Nutr.* 43: 795-802, 1986.

47. MA Staten, DE Matthews & DM Bier: Leucine metabolism in type ll diabetes mellitus. *Diabetes* 35: 1249-1253, 1986.

48. VR Young, NK Fukagawa, DM Bier & DE Matthews: Some aspects of in vivo human protein and amino acid metabolism, with particular reference to nutritional modulation. *Verh. Dtsch. Ges. Inn. Med.* 92: 640-665, 1986.

49. RD Yang, DE Matthews, DM Bier, Z-M Wen & VR Young: Response of alanine metabolism in humans to manipulation of dietary protein and energy intakes. *Am. J. Physiol. Endocrinol. Metab.* 250: E39-E46, 1986.

50. D Darmaun, DE Matthews & DM Bier: Glutamine and glutamate kinetics in humans. *Am. J. Physiol. Endocrinol. Metab.* 251: E117-E126, 1986.

51. VR Young, C Gucalp, WM Rand, DE Matthews & DM Bier: Leucine kinetics during three weeks at submaintenance-to-maintenance of leucine in men: Adaption and accommodation. *Hum. Nutr. Clin. Nutr.* 41: 1-18, 1987.

52. SJ Fomon, DE Matthews, DM Bier, RR Rogers, CJ Rebouche, BB Edwards & SE Nelson: Bioavailability of dietary urea nitrogen in the infant. *J. Pediatr.* 111: 221-224, 1987.

53. KS Nair, D Halliday, DE Matthews & SL Welle: Hyperglucagonemia during insulin deficiency accelerates protein catabolism. *Am. J. Physiol. Endocrinol. Metab.* 253: E208-E213, 1987.

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54. D Darmaun, DE Matthews, J-F Desjeux & DM Bier: Glutamine and glutamate nitrogen exchangeable pools in cultured fibroblasts: A stable isotope study. *J. Cell. Physiol.* 134: 143-148, 1988.

55. KS Nair, PD Woolf, SL Welle & DE Matthews: Leucine, glucose, and energy metabolism after 3 days of fasting in healthy human subjects. *Am. J. Clin. Nutr.* 46: 557-562, 1987.

56. MA Staten, DE Matthews, PE Cryer & DM Bier: Physiologic increments in epinephrine stimulate metabolic rate in humans. *Am. J. Physiol. Endocrinol. Metab.* 253: E322-E330, 1987.

57. KJ Tracey, A Legaspi, JD Albert, M Jeevanandam, DE Matthews, MF Brennan & SF Lowry: Protein and substrate metabolism during starvation and parenteral refeeding. *Clin. Sci.* 74: 123-132, 1988.

58. NK Fukagawa, KL Minaker, JW Rowe, DE Matthews, DM Bier & VR Young: Glucose and amino acid metabolism in aging man: Differential effects of insulin. *Metabolism* 37: 371-377, 1988.

59. SJ Fomon, DM Bier, DE Matthews, RR Rogers, BB Edwards, EE Ziegler & SE Nelson: Bioavailability of dietary urea nitrogen in the breast-fed infant. *J. Pediatr.* 113: 515-517, 1988.

60. J Cortiella, DE Matthews, RA Hoerr, DM Bier & VR Young: Leucine kinetics at graded intakes in young men: Quantitative fate of dietary leucine. *Am. J. Clin. Nutr.* 48: 988-1009, 1988.

61. LJ Hoffer, RD Yang, DE Matthews, BR Bistrian, DM Bier & VR Young: Alanine flux in obese and healthy humans as evaluated by ^{15}N- and $^{2}H_3$-labeled alanines. *Am. J. Clin. Nutr.* 48: 1010-1014, 1988.

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72. C Couet, NK Fukagawa, DE Matthews, DM Bier & VR Young: Plasma amino acid kinetics during acute states of glucagon deficiency and excess in healthy adults. *Am. J. Physiol. Endocrinol. Metab.* 258: E78-E85, 1990.

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74. M Yagi, DE Matthews & M Walser: Nitrogen sparing by 2-ketoisocaproate in parenterally fed rats. *Am. J. Physiol. Endocrinol. Metab.* 259: E633-E638, 1990.

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INVITED TALKS AND LECTURES:

1. Gas Chromatography-Mass Spectrometry Workshop, 24th Annual Conference on Mass Spectrometry and Allied Topics, San Diego, CA, May 13, 1976.
2. Short Course on Biomedical Mass Spectrometry, 26th Annual Conference on Mass Spectrometry and Allied Topics, St. Louis, MO, June 2-3, 1978.
3. Department of Chemistry, DePauw University, Greencastle, IN, Oct. 30, 1980.
4. Symposium on *Nitrogen Metabolism in Man,* Ocho Rios, Jamaica, Nov. 22, 1980.
5. Metabolism in Stress and Trauma Club, Harvard Medical School, Boston, MA, June 18, 1981.
6. Gas Chromatography-Mass Spectrometry Workshop, American Association for Clinical Chemistry, 33rd National Meeting, Kansas City, MO, July 21, 1981.
7. International Symposium on *The Synthesis and Applications of Isotopically Labeled Compounds*, Kansas City, MO, June 9, 1982.
8. Metabolism in Stress and Trauma Club, Harvard Medical School, Boston, MA, Sept. 16, 1982.
9. Workshop on *The Quantitation of Isotopic Enrichment in Gases Derived from Biological Samples*, 31st Annual Conference on Mass Spectrometry and Allied Topics, Boston, MA, May 11, 1983.
10. Department of Surgery, Emory University School of Medicine, Atlanta, GA, June 8, 1983.
11. Department of Pediatrics and Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX, Aug. 24, 1983.
12. The Rowett Research Institute, Aberdeen, Scotland, Sept. 20, 1983.
13. Department of Chemistry Symposium *Chemical Measurements and Characterization*, Indiana University, Bloomington, IN, Oct. 21, 1983.
14. The Clinical Research Centre of the Medical Research Council's 3rd International Symposium: *Substrate and Energy Metabolism in Man*, Harrow, England, Sept. 17-19, 1984.
15. Department of Surgery, Emory University School of Medicine, Atlanta, GA, Oct. 10, 1983.
16. Seminar in Endocrinology and Metabolism, University of Rochester School of Medicine, Rochester, NY, March 12, 1985.
17. Clinical Research Facility, Emory University School of Medicine, Atlanta, GA, Aug. 6, 1985.
18. Symposium on *Stable Isotopes in Clinical Nutrition*, European Society of Parenteral and Enteral Nutrition, 7th Congress, Munich, Germany, Sept. 10, 1985.
19. Mini-Conference on *Protein and Energy Metabolism*, Department of Food and Nutrition, Barnes Hospital, St. Louis, MO, Nov. 20, 1985.
20. Division of Biochemical Development and Molecular Diseases, Children's Hospital of Philadelphia, University of Pennsylvania School of Medicine, Philadelphia, PA, March 21, 1986.
21. The National Institute of Arthritis, Diabetes, Digestive and Kidney Diseases and the Cystic Fibrosis Foundation Joint Conference: *Nutrition in Cystic Fibrosis*, Bethesda, MD, April 2, 1986.
22. The Silver Jubilee Eastern Analytical Symposium: *Clinical Applications in Mass Spectrometry*, New York, NY, Oct. 23, 1986.
23. Department of Chemistry, Indiana University, Bloomington, IN, March 11, 1987.
24. Department of Chemistry, DePauw University, Greencastle, IN, March 12, 1987.
25. *Symposium on a Primer in Isotope Tracer Kinetics*, 12th Clinical Congress, American Society for Parenteral and Enteral Nutrition, Las Vegas, Nevada, January 19, 1988.
26. Obesity Research Center, St. Luke's-Roosevelt Hospital Center, New York, NY, January 29, 1988.
27. Seminars in Research Medicine, Rockefeller University Hospital, New York, NY, May 18, 1988.
28. Division of Endocrinology, Department of Medicine, Yale University School of Medicine, New Haven, Conn., May 23, 1988.
29. Workshop on *Recent Advances of Stable Isotopes in Nutritional Research*, European Society of Parenteral and Enteral Nutrition, 10th Congress, Leipzig, German Democratic Republic, August 25, 1988.
30. Divisione di Medicina, Ospedale San Raffaele, Istituto Di Ricovero e Cura a Carattere Scientifico, Milan, Italy, August 29, 1988.
31. Clinical Nutrition Research Center, University of Chicago School of Medicine, Chicago, Ill., October 25, 1988.

INVITED TALKS AND LECTURES:

32. Research Workshop on *Endocrine Regulation of Protein Metabolism*, 13th Clinical Congress, American Society for Parenteral and Enteral Nutrition, Miami, Florida, February 5, 1989.

33. Division of Biochemical Development and Molecular Diseases, Children's Hospital of Philadelphia, University of Pennsylvania School of Medicine, Philadelphia, Penn., March 7, 1989.

34. Department of Surgery, Vanderbilt University School of Medicine, Nashville, Tenn., March 17, 1989.

35. Kabi-Vitrum International Workshop on Glutamine, Stockholm, Sweden, September 9, 1989.

36. Conference on Mathematical Models in Experimental Nutrition, Gatlinburg, Tenn., October 16, 1989.

37. Symposium on *Amino Acid/Protein Metabolism in Health and Disease*, Scientific Institute of the Hospital San Raffaele, Milan, Italy, January 19, 1990.

38. Organizer and co-chairperson of the Research Workshop on *Regulation of Energy Metabolism*, 14th Clinical Congress, American Society for Parenteral and Enteral Nutrition, San Antonio, Texas, January 28, 1990.

39. Session on *New Biology and Nutrition* in Biomedical Research, AAAS 156th national meeting, New Orleans, La., February 17, 1990.

40. Symposium on *Nutrition and Metabolism*, Deutsche Arbeitsgemeinschaft für Künstliche Ernährung and Österreichische Arbeitsgemeinschaft für Künstliche Ernährung, Vienna, Austria, March 29, 1990.

41. Department of Pediatrics, Children's Hospital, Wilhelm-Pieck Universität Rostock, Rostock, GDR (East Germany), April 4, 1990.

42. Perinatal Center, Department of Pediatrics, Rainbow Babies & Children's Hospital, Cleveland, Ohio, August 22, 1990.

43. Symposium on *Branched-Chain Amino Acids: Biochemistry, Physiology, and Clinical Science*, by the Nutrition Foundation of Italy, Monte Carlo, Monaco, April 18, 1991.

44. Organizer and speaker, Symposium on *Whole Body Metabolism Using Isotopic Tracers*, American Gastroenterological Association Annual Meeting and Digestive Disease Week, New Orleans, La, May 21, 1991.

45. Endocrine Grand Rounds and Endocrine Research Conference lectures, Mayo Clinic, Rochester Minn., May 29-30, 1991.

46. Symposium on *Regulation of Protein Metabolism*, 14th International Diabetes Federation Congress, Washington, DC, June 25, 1991.

47. Symposium on *Protein Metabolism in Diabetes Mellitus*, Burlington, VT, July 1, 1991.

48. Endocrinology, Metabolism and Nutrition Unit, University of Vermont Medical College, Burlington, Vt, June 17, 1992.

49. Symposium on *Nutrition and Intestinal Function*, European Society of Parenteral and Enteral Nutrition, 14th Congress, Vienna, Austria, September 8, 1992.

50. Symposium on α *-Ketoglutarate and Analogs: Metabolic and Nutritional Aspects*, Vienna, Austria, September 10, 1992.

51. Third International Symposium on *Protein and Amino Acid Metabolism*, Bologna, Italy, November 16, 1992.

52. Seventh Postgraduate Course on *Recent Advances in Anaesthesia, Pain, Intensive Care and Emergency Medicine*, Trieste, Italy, November 27, 1992.

53. Co-chairperson & speaker at the Research Workshop on *Body Composition*, 17th Clinical Congress, American Society for Parenteral and Enteral Nutrition, San Diego, CA, February 14, 1993.

54. The Second Clintec International Horizons Conference on *Organ Metabolism and Nutrition: Ideas for the Future Critical Care*, Amsterdam, The Netherlands, May 17, 1993.

55. Surgery Research Conference, Department of Surgery, Stony Brook Health Sciences Center, Stony Brook, NY, March 18, 1994.

56. Seminars in Clinical Research, Rockefeller University, New York, NY, March 23, 1994.

57. International Federation of Automatic Control Conference on *Modeling and Control in Biomedical Systems*, Galveston, TX, March 30, 1994.

58. FASEB 1994 Workshop on *Doubly Labeled Water Method for Measurement of Total Energy Expenditure: Recent Advances*, Anaheim, CA, April 25, 1994.

59. Basic Science Lecture, Harbor-UCLA Medical Center, Torrance, Calif., April 26, 1994.

INVITED TALKS AND LECTURES:

60. United States Department of Agriculture Children's Nutrition Research Center at Baylor College of Medicine, Houston, TX, May 12, 1994.
61. Medizinische-Klinik IV, Allgemeines Krankenhaus der Stadt Wien, Vienna, Austria, June 22, 1994.
62. Pediatric Gastroenterology, Children's Hospital of Philadelphia, Philadelphia, PA, August 3, 1994.
63. Lecture in the *Biochemical and Physiological Bases of Nutrition* course, Institute of Human Nutrition, Columbia University College of Physicians and Surgeons, New York, NY, October 17, 1994.
64. Research seminar in the Department of Nutritional Sciences, Rutgers University, New Brunswick, NJ, October 24, 1994.
65. Lecture in the *Principles of Nutrition Research* course in the Department of Nutritional Sciences, Rutgers University, New Brunswick, NJ, October 24, 1994.
66. Research Workshop on *Substrate Metabolism in Humans*, 19th Clinical Congress, American Society for Parenteral and Enteral Nutrition, Miami Beach, FL, January 15, 1995.
67. Symposium on *Substrate Metabolism in Humans*, 19th Clinical Congress, American Society for Parenteral and Enteral Nutrition, Miami Beach, FL, January 16, 1995.
68. Symposium on *Wasting Disorders: Molecular and Clinical Aspects* by Serono Symposia USA, Ft. Lauderdale, FL, February 24, 1995.
69. Laboratoire de Biochimie, Hôpital Saint-Antoine, Paris, France, March 7, 1995.
70. Laboratoire de Nutrition Humaine, Clermont-Ferrand, France, March 8, 1995.
71. Symposium on *Pharmacological Nutrition - Immune Nutrition* by Fresenius, Nice, France, March 10, 1995.
72. University of Vermont College of Medicine Clinical Research Center, Burlington, VT, May 23, 1995.
73. St. Luke's Roosevelt Hospital Obesity Research Center, New York, NY, June 9, 1995.
74. Lectures in *Advanced Nutrition* in the Departments of Health and Nutrition Education, Columbia University Teachers College, November 14th and 21st, 1995.
75. Symposium on *Metabolism: Update on Substrates and Hormones*, 20th Clinical Congress, American Society for Parenteral and Enteral Nutrition, Washington, DC, January 16, 1996.
76. Fourth International Symposium on *Amino Acid/Protein Metabolism in Health and Disease*, Padua, Italy, April 12, 1996.
77. Cattedra di Malattie del Ricambio Dip. di Medicina Clinica e Sperimentale, University of Padua, Padua, Italy, April 16, 1996.
78. Symposium on *In Vivo Tracer Kinetics and Modeling,* National Institutes of Health, Bethesda, MD, May 3, 1996.
79. School of Dietetics and Human Nutrition, Macdonald Campus, McGill University, Montreal, Canada, April 15, 1997.
80. Stable Isotope Group, McGill University, Montreal, Canada, April 15, 1997.
81. Europa Scientific, Crewe, Cheshire, England, August 6, 1997.
82. Division of Nutritional Sciences, Cornell University, April 6, 1998.
83. Nemours Children's Clinic, Jacksonville, FL, June 4, 1998.
84. Department of Chemistry, Stonehill College, Easton, MA, December 11, 1998.
85. North American Association for the Study of Obesity Annual Meeting, Tutorial on Using Stable Isotopes to Study Metabolism, Charleston, SC, November 15, 1999.
86. Yale University, the John B. Pierce Laboratory, April 10, 2000.
87. Nestlé Research Center, Nestec Ltd, Lausanne, Switzerland, May 8, 2000.
88. Ajinomoto Symposium on Glutamine, Bermuda, October 2, 2000.
89. Organizer, co-chairperson and speaker for the NIH NIDDK-sponsored Research Workshop on *Using Tracers to Measure Carbohydrate, Fat and Amino Acid Metabolism in Humans*, Nutrition Week 2003, San Antonio, Texas, January 18, 2003.
90. United States Anti-Doping Agency (USADA) 2nd Annual Research Symposium on *Application of Gas Chromatography/Combustion/Isotope Ratio Mass Spectrometry (GCC IRMS) to Doping Control*, Los Angeles, Calif, August 21-23, 2003.

INVITED TALKS AND LECTURES:

91. ESPEN (European Society of Parenteral & Enteral Nutrition) Course in Tracer Methodology in Metabolism 2004, Maastricht, Netherlands, January 31-February 1, 2004.

92. Symposium on *Amino Acid/Protein Metabolism in Health and Disease VI International Conference*, Società Italiana di Diabetologia, Società Italiana di Nutrizione Parenterale ed Enterale, Società Italiana di Nutrizione Umana, Milan, Italy, March 25-26, 2004.

93. The Fourth Workshop on *the Assessment of Adequate Intake of Dietary Amino Acids*, Kobe, Japan, October 28-29, 2004.

94. Workshop on *Current Topics in Neonatal/Infant Nutrition and Metabolism V: Methionine Metabolism and Epigenetics*, USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine and the Robert Schwartz M.D. Center for Metabolism & Nutrition, Case Western Reserve University School of Medicine, Houston, TX, January 11-12, 2005.

95. ESPEN (European Society of Parenteral & Enteral Nutrition) Course in Tracer Methodology in Metabolism 2005, Maastricht, Netherlands, February 5-6, 2005.

96. Nestlé Research Center, Lausanne, Switzerland, March 21, 2005.

97. The Vernon Young Symposium: Historical Contributions of Isotopes to the Understanding of Nutrient Metabolism, ASNS Experimental Biology 2005 Symposium, San Diego, CA, April 3, 2005.

98. The Biological Mass Spectrometry Symposium, sponsored by Cambridge Isotope Laboratories and the Washington University Mass Spectrometry Research Resource, San Diego, CA, April 4, 2005.

99. ESPEN (European Society of Parenteral & Enteral Nutrition) Course in Tracer Methodology in Metabolism 2006, Stockholm, Sweden, June 10-11, 2006.

100. Transdisciplinary International Conference on Aromatic Amino Acids and Related Substances: Chemistry, Biology, Medicine and Applications, Vancouver, British Columbia, Canada July 20-21, 2006.

101. University of Florida, Department of Food Science and Human Nutrition, Gainesville, FL, November 2, 2006.

102. Louisiana State University, The Pennington Biomedical Research Center, Baton Rouge, LA, November 16, 2006

103. The Academy of Muscle Biology, Exercise and Health Research (Copenhagen, Denmark) Winter Symposium in Methods in Research – From Molecule to Man, St. Christoph, Austria, January 13-20, 2007.

104. Symposium on NIH Peer Review, Experimental Biology, Washington, DC, April 28, 2007.

105. NIH-NIDDK sponsored course on Isotope Tracers in Metabolic Research: Principles and Practice of Kinetic Analysis, Little Rock, Arkansas, October 8-11, 2007.